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Original Article

# ELECTRO IMPULSE TREATMENT - ENERGY EFFICIENCY FACTOR DURING DRYING OF AGRICULTURAL PRODUCTS

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***ABSTRACT***

***The article presents the results of research on the development of energy-saving electrical technology of drying fruits and grapes. The mechanism of the impact of the electropulse discharge on the structure and properties of the fruits of grapes is analyzed. A scheme is proposed for the distribution and distribution of discharge currents and an equivalent circuit for replacing the tissue of a grapefruit as an object of electrical action. To intensify the drying process, the duration of which depends on its energy intensity and energy content of dried products, it is proposed to the pre-electropulse treatment of grape before drying, ensuring maximum deactivation of tissue cells, as the main factor preventing moisture removal. The paper also provides a diagram of the manifestation of the impact of electropulse energy as a factor of energy saving during drying.***

***The article presents the results of an experimental study to determine the effect of electropulse treatment on the duration of their subsequent drying for some varieties of fruits and grapes and their mathematical models. The use of renewable energy sources to improve the energy efficiency of drying agricultural products in the work is indicated as a promising direction.***

***KEYWORDS: Electropulse Discharge, Biological Object, Intercellular Connection, Membrane Permeability, Disturbance of Water Structure, Microcracks on the Skin, Removal of Wax Deposits, Hygroscopic Equivalent Circuit, Degree of Damage, Electromagnetic Energy, Radiation Energy, Protein Coagulation, Cell Membrane, Currents Bridges, Energy And Power of A Single Discharge, Specific Energy Consumption, Blanching, Thermoplasmolysis, Energy Value, Dried Products & Renewable Energy Sources GI (RES)***

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## INTRODUCTION

The climatic conditions of the Central Asian republics create favorable conditions for the development of horticulture, fruit growing and vegetable growing. In 2017 in Uzbekistan, compared to 2000, the size of orchards increased by 85.6 thousand hectares, vineyards by 13.2 thousand hectares. In 2017, 31.0 million tons of fruit and vegetable products were produced. At the same time, up to 30% of the produced products do not reach consumers and this is mainly due to the lack of energy efficient technologies and technical solutions for their processing (drying, storage, canning, and others). Solving problems that arise requires complex studies aimed at improving the energy efficiency of energy-intensive processing processes, in particular, drying, taking into account the characteristics of the object and the requirements for dried products.

## RESEARCH METHODOLOGY AND RESULTS

Research methodology. When studying the effects of an electric pulse discharge on the structures and properties of biological objects of plant origin, we used the laws of biophysics, electrical engineering, and the laws of the transfer and absorption of energy by matter. Changes in anatomical and ultrastructural structures were studied by microscopic observation. Evaluation of the biological state of the material was carried out according to the degree of tissue damage S and the method of electrical conductivity. Experimental studies were carried out on a specially designed stand using the general methodology for conducting and processing an experiment and the mathematical theory of planning multifactor experiments.

## RESULTS

The data on the effects of the electric pulse discharge on whole grapes and fruits, which reveal the mechanism of the damage of their cells, are insufficiently covered in the literature and require special studies. In addressing this issue, we have studied and established provisions that are either directly or indirectly related to the disclosure of the mechanisms of action of an electric pulse discharge on the structural structure, biological properties, parameters of an electric pulse discharge, etc. Based on the data obtained in the study of electrophysical properties, it is possible to propose a scheme for the distribution of discharge currents and an equivalent scheme for replacing the tissue of fruits and grapes during their electric pulse treatment (Figure 1). In contrast to the equivalent circuits cited in the literature, in the proposed scheme, the elements of the circuit characterizing electrical conductivity (electrical resistance) are adopted as variables, since the concentration of cell and intercellular juices will change as the electric pulse discharges. The variability of the electrophysical properties of the membranes of the cell is taken on the basis of the resulting redistribution of juices in its inner and outer walls during electropulse processing. Based on the literature data on the effect of the electropulse discharge on plant materials, taking into account the specific features of the structure and properties, as well as the results of our research, the following changes in the cells and tissues of fruits and grapes during electropulse processing are assumed: destruction of the intercellular connection (maceration), increase in tissue porosity and permeability membranes due to coagulation of membrane proteins, disruption of the orderliness of the water structure (relaxation of the hydrogen bond between water molecules), the formation of a microcrack on the skin and removing waxy coating, as well as disruption stomata disclosure.

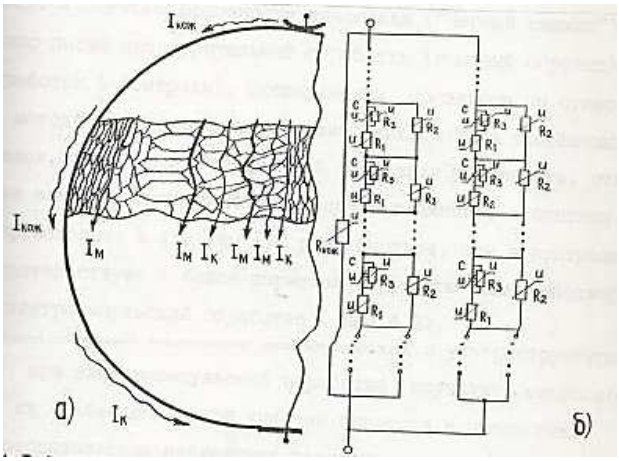


**Figure 1: The Distribution Pattern of the Discharge Current (a) and the Equivalent Circuit for Replacing the Tissue of Fruits and Grapes (b)**

The reliability of these assumptions is established on the basis of special studies, as well as from literature data on the influence of electrophysical factors on biological objects. The phenomena of sorption and changes in the equilibrium moisture content were studied by studying the porosity of grapes ("Black Sultana grape"), dried after pretreatment (prototype) and without treatment (control). The experiments were carried out according to the existing method of studying the hygroscopic properties of dried materials /1, 2 /. The research results allowed to establish that the absorption of moisture and the achievement of equilibrium moisture in the test sample occurred on average 1.2 times faster than in the control, indicating a more porous structure of the tissue subjected to electropulse treatment (Figure 2). Changes in anatomical and ultrastructural structures with electropulse treatment were studied by microscopic observation with the participation of biologists and cytologists.

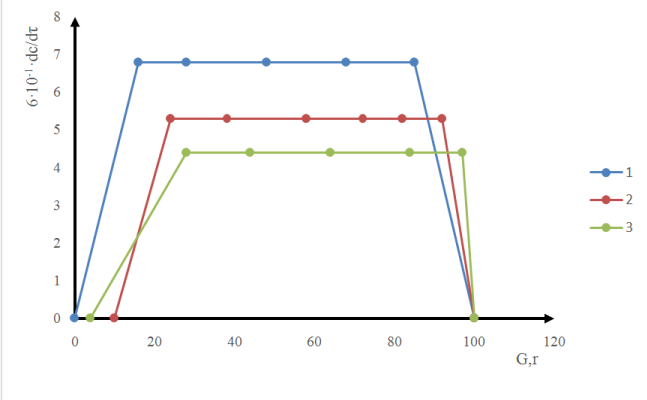


**Figure 2: Moisture Evaporation Rate: 1-Out of Water 2-From the Juice of Grapes Subjected to Electro Treatment**

Microscopic observations made it possible to establish the following

- During electric treatment, the skin of grapes and fruits remains intact without overlapping, and with overlapping, it is cleaned of wax deposits and is covered by microcracks along the discharge channel
- With a needle-shaped potential electrode, slight skin damage is observed at the impulse input sites
- Tissue cells exfoliate from each other and freely float in the intercellular juice, and the cell walls remain without damage, i. e . maceration occurs.

To verify the assumptions made on the basis of the above arguments, a special study was conducted involving the determination of the intensity of evaporation of water from the juice of the Black Sultana grapes treated with electropulse discharges compared to the juice of the raw grapes.

To assess the impact of electropulse treatment in further studies we take the cell damage degree indicator, which is widely used in the study of electrical biological objects. The degree of damage S characterizes the relative change in the biological properties of the structural structure of the object under the influence of an electric pulse discharge without taking into account the change in the binding energy of moisture that occurs during processing. The last indicator of the influence of electrical effects is essential when assessing the energy costs of drying plant materials subjected to electro-treatment.

Based on the analysis of the available data on the effect of electrical processing on plant materials and the results of our own research, it is possible to draw up a structural diagram of the manifestation of the impact of electric pulse

energy as a factor of energy saving during drying (Figure 3)

The block diagram indicates that the energy of an electropulse discharge is partially absorbed by the material, partially lost in the environment in the form of dissipation of electromagnetic energy and radiation energy.

The absorbed part of the energy manifests itself in the form of thermal, mechanical, electrochemical and electrophysical effects causing irreversible structural and biological changes in the tissues and cells of the processed products, assessed by the degree of damage to the biological object S. In addition, the result of electrochemical and electrophysical processes occurring under the influence of grad E and grad H, change the energy of the bond of water with matter and the degree of order of its structure.

Thus, the results of the study allowed to establish

- The main damaging factors of the electropulse discharge are discharge currents, electric and magnetic field strength and duration of treatment (number of pulses)
- Decrease in the water-holding capacity of the tissue of plant materials, in particular, fruits and grapes, treated with electropulse discharges without overlap, is mainly due to the cell necrosis due to mechanical destruction of its cytoplasm and intercellular communication (maceration) under the action of hydrodynamic force generated in the discharge channel, ion dissociation under the action gradient of the electric field arising between the inner and outer walls of the cell, as well as in connection with the occurrence of coagulation of the white s cell membrane due to the conduction current.

In addition, the violation of the degree of ordering of the structure of water in the cell sap under the action of a pulsed current also reduces the binding energy of the water molecule and, accordingly, the energy consumption for the removal of moisture during subsequent drying. The established pattern of electropulse processing and changes in the degree of damage to cells of the tissue of fruits and grapes requires determining the relationship between the main factors affecting the electric pulse discharge (U, C, n) and the indicator of the degree of damage to tissue S.

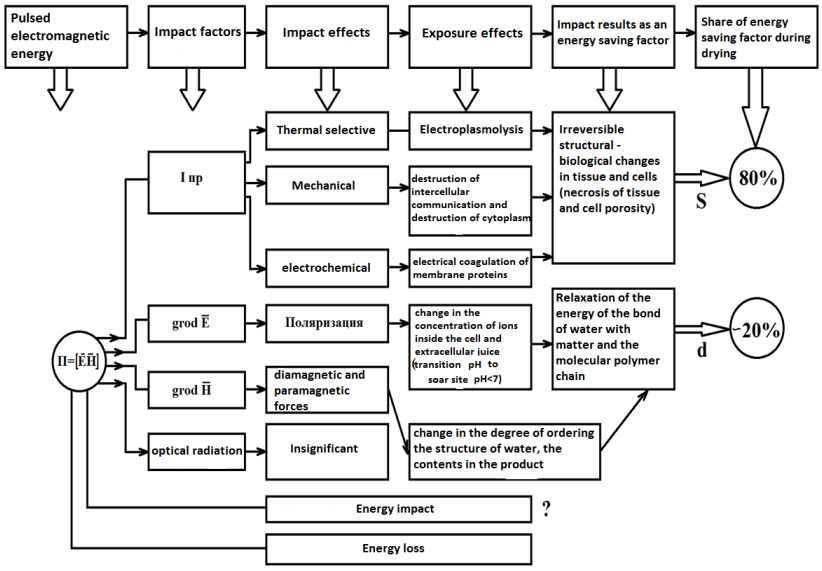


**Figure 3: Block Diagram of the Manifestation of the Impact of Electropulse Energy as a Factor of Energy Saving During Drying**

Based on the analysis of the effects of electrophysical influences on plant material and preliminary experiments, we have adopted the following parameters of the measuring circuit when determining the total resistance of the tissue: measurement voltage U = 6-8 V, frequency of measuring current f = 103 Hz. The source of energy for measurements is a signal generator of the type G3-33. The accepted values of U and f will eliminate polarization and heating of the object under study. As measuring electrodes, stainless steel needle electrodes were used, mounted on an insulating base at a distance of 10 mm from each other. To study the effect of electrical processing parameters on the degree of damage to the tissue of fruits and grapes, a laboratory stands consisting of pulsed energy sources with capacitive storage, a high-frequency signal generator, a voltage regulator, measuring instruments (kilovolt meters, ammeters, voltmeters) and a high-voltage switch was developed. The electrical circuit of the laboratory bench is shown in Figure 4. The developed laboratory bench allows changing the discharge voltage (U), storage capacitor capacitance (C), number of pulses (n), and observing the readings of the instruments. According to the testimony of the devices, the current values in the raw fruits and grapes were determined. Then, alternately, pulsed discharges were applied to fruits or grapes mounted on grounded metal surfaces through needle electrodes mounted directly on the surface of the processed product.

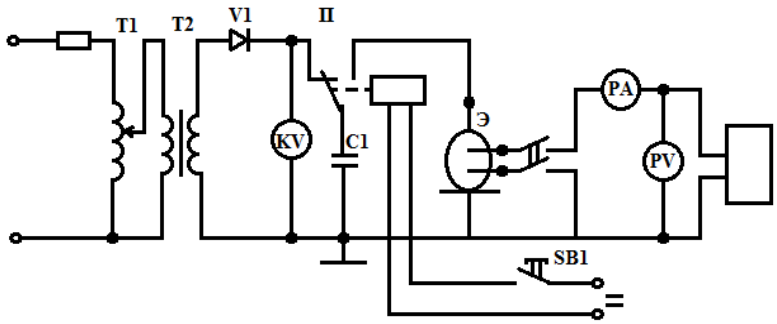


**Figure 4: Electrical Circuit Diagram of the Laboratory Stands for Studying the Effect of Electrical Treatment Parameters on the Degree of Tissue Damage in Fruits and Grapes**

According to the indications of the devices, the degree of tissue damage of the processed fruits and grapes was calculated in relative units or as a percentage of the limiting value and other values characterizing the process (energy and power of a single discharge, specific energy consumption, etc.).

For a more complete identification of the mechanism of electrical treatment on the anatomical ultrastructural structure of tissue cells, along with an electrophysical method, we conducted microscopic studies of fruits and grapes with the involvement of biologists.

Thus, the method of research of electropulse processing, developed on the basis of existing methods, taking into account the technological features of fruits and grapes, the mechanisms of electrical action during their processing and the pursued goal, allows you to

- Set the parameters of electropulse treatment and the relationship between the parameters of electrical effects and the object of treatment
- To study structural (anatomical and ultrastructural) changes occurring in fruits and their constituent components (skin, pulp, etc.) during electro treatment

- Study the energetics of the process and establish the relationship between the parameters of electrical effect and the degree of tissue damage.

The study revealed that the degree of damage to tissue cells depends on the energy of a single impulse $W_{one}$ supplied to the product and the number of impulses n. At the same time, the maximum deactivation of tissue cells ($S = 95–98\,\%$) was achieved with the following parameters: for grapes of $W_{gp} = 8 \cdot 10^3$ kJ, n = 16-18 imp; stone fruit and pome fruit $W_{gp} = 12 \cdot 10^3$ kJ, n = 8-12 imp.

According to the results of theoretical studies, factors determining the course of the electropulse process were identified: discharge voltage (U), discharge capacitor capacitance (C), and a number of pulses (n).

The degree of damage (S) was adopted as the parameter characterizing the processed products.

According to the results of experimental studies and their mathematical processing, we obtained dependences that characterize the change in the degree of damage to the tissue of fruits and grapes driven by electrical processing. Figure 5. shows the dependence of the degree of damage to grapes of the “Sultana Black grape” variety on the voltage of the electric discharge. The analysis of the curves suggests that an increase in the discharge voltage to 5-6 kV is accompanied by an increase in the degree of damage S, and a further increase in U is characterized by a decrease in the damaging effect, which is obviously due to the predominance of the surface current of the discharge over the volume passing directly through the pulp of the grapes.

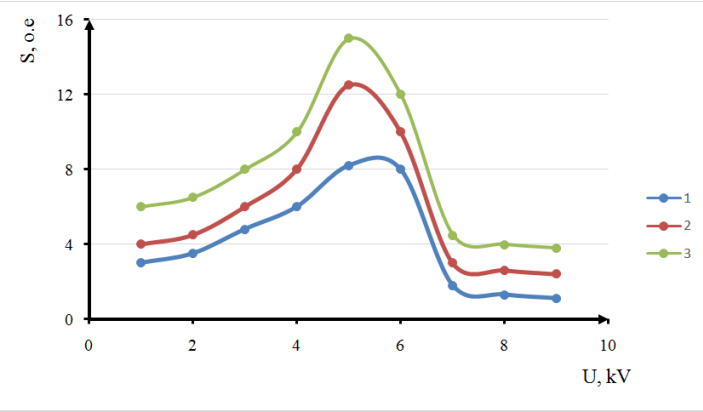


**Figure 5: The Dependence of the Degree of Damage to the Tissue of Grape Berries "Sultana Grape Black" from the Voltage of Electrical Discharges $S = f(n)$ (C=0, 1μF and the Number of Digits: 1 – n=4; 2- n=3; 3 – n=14)**

According to the results of the study of the effect of the number of pulses (n) on the degree of damage S, graphical dependencies for the fruits of grapes were obtained (Figure 6).

An analysis of the patterns of their change shows that cell death is intense, due to the impact of the initial impulses, a further increase does not give a significant change. Full immobilization of the tissue of fruits and grapes, respectively, is achieved at 8-12 and 16-18 pulses. The study of the effect of the storage capacitor capacitance (C) on the degree of S cell damage allowed to establish the relationship between them (Figure 7).

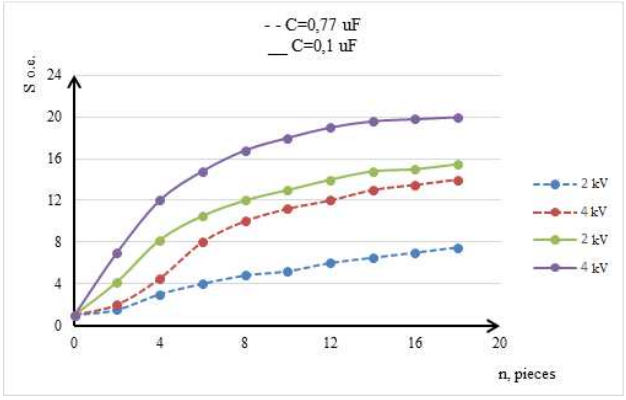


**Figure 6: Dependence of the Degree of Damage to the Tissue of the "Sultana Black Grape" Berry on the Number of Pulses (at C = 0.77 µF and C = 0.2 µF, at U = 2.0 kV and U = 4.0 kV)**

The analysis of the dependence S = f (C) shows that with an increase in the capacity of the storage capacitor to a certain value (0.3-0.4 microfarads for grapes; 0.35-0.45 microfarads for pome fruit), the degree of tissue damage increases, and a further increase due to the predominance of the surface discharge over the volume is accompanied by a decrease in the effect of defeat the pulp.

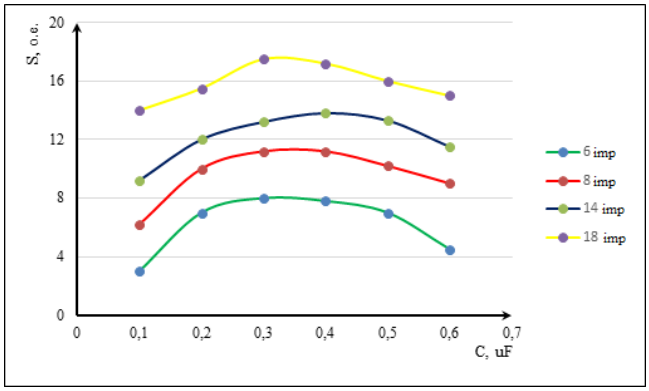


**Figure 7: Dependences of the Degree of Damage to Kishmish Black Grapes on the Capacity of the Discharge Capacitor (at U = 4 kV and the Number of Pulses 6, 8, 14 and 19 imp)**

One of the main factors determining the efficiency of electropulse treatment is the energy of a single pulse, the determination of which is necessary for the selection of a generator of high voltage pulses. The energy of a single discharge can be adjusted by changes in U and C. However, the lower limit of U is limited by the insufficient effect of processing, the upper by the occurrence of an arc along the surface of the berry, therefore changes in the energy of a single impulse are mainly achieved by changing C. An increase in the discharge energy due to an increase in the capacity of the storage capacitor leads to more intensive destruction of the cell membranes, but at the same time an increase in the energy of a single impulse led to a sharp increase in the specific energy consumption for processing raw materials (Figure 8). The maximum necrosis of grapefruit tissue, respectively, is achieved at 8-12 pulses. The study of the degree of damage to the tissue of the Black Kishmish grape from the discharge voltage, the number of pulses and the balancing time allowed us to establish the relationship between them (Figure 9).

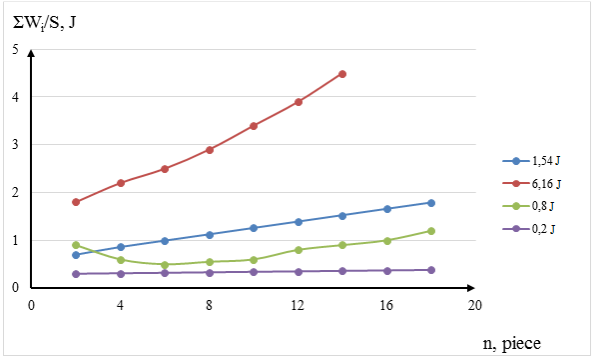


**Figure 8: The Dependence of the Specific Energy Consumption on the Number of Pulses for different Values of the Pulse Energy is - 0.2; 0.8; 1.54; 6.16 kJ (for Black Sultana Grapes)**

A slight damage to the tissue, the grapes when liquid blanching is due to the fact that during processing for 5-10 s only the surface layer of the berry is subjected to thermo plasmolysis.

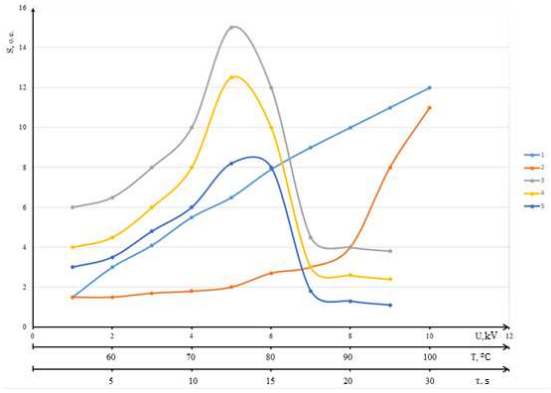


**Figure 9: Dependence of the Degree of Damage to the Tissue of the Black Sultana Grapes on the Discharge Voltage (curve 3,4,5), the Number of Pulses (Curve 1) and the Balancing Time (Curve 2)**

The energy consumption for liquid balancing is 250-300 kJ per 1 kg of the grapes to be processed. The results of experimental studies have shown that electropulse processing of fruits and grapes at discharge voltages U = 5-7 kV and capacitor capacitance C = 0.3-0.4 μF and the number of pulses, n = 8-18, leads to maximum damage to the cells of their tissue analyzing the influence of the number of impulses on the degree of damage, we note that from the initial impulses the tissue is affected more intensively than from subsequent ones, and at certain values, the degree of damage to the tissue of fruits and grapes is almost unchanged, which apparently corresponds to the complete death of living tissue cells. The processing of fruits, and especially grapes, carried out in two stages, initially by the surface, and then by volumetric discharges, provides intensive drying in combination with the production of dried raw materials with a good presentation. To identify the complex effects of the main factors (discharge voltage U, discharge capacitor capacitance C, number of pulses n), the level of impact on the degree of damage and to develop a mathematical model of the electrical processing process of some grape varieties and fruits, we carried out studies using the mathematical theory of planning multivariate experiments / 20, 21 /. On the basis of preliminary experiments, the main factors affecting the degree of damage to the tissue of fruits and grapes, the main levels and intervals of their variation were identified. The main factors affecting the degree of damage to tissue cells are the discharge voltage (X1), the number of pulses (X2) and the capacity of the discharge capacitor (X3)

**Table 1: Intervals and Levels of their Variation**

| Designation of Factors | | Factor | Levels | | | Interval | Impact Object |
|---|---|---|---|---|---|---|---|
| Coded | Natural | | -1 | 0 | +1 | | |
| $X_1$ | U | Discharge voltage, kV | 2 | 4 | 6 | 2 | Plum: Isfandyk |
| | | | 1 | 3 | 5 | 2 | Apples |
| | | | 3 | 5 | 7 | 2 | Apricots |
| | | | 2 | 3 | 4 | 1 | "Black Sultana grape " and "white" |
| | | | 2 | 4 | 6 | 2 | Nimrang Grapes |
| | | | 2 | 3,5 | 5 | 1,5 | Grapes "Tayfi pink" |
| | | | 2 | 3,5 | 5 | 1,5 | Grapes "Muscat of Alexandria" |
| $X_2$ | n | Number of pulses, pcs. | 6 | 13 | 20 | 7 | Plum: Isfandyk |
| | | | 4 | 7 | 10 | 3 | An Apple |
| | | | 6 | 9 | 12 | 3 | Apricots |
| | | | 6 | 12 | 18 | 6 | "Black Sultana grape " and "white" |
| | | | 8 | 16 | 24 | 8 | Nimrang Grapes |
| | | | 8 | 14 | 22 | 8 | Grapes "Tayfi pink" |
| | | | 6 | 14 | 22 | 8 | Grapes "Muscat of Alexandria" |
| $X_3$ | C | Capacity of discharge capacitor, uF | 0,1 | 0,435 | 0,7 | 0,335 | For all grapes, apples, plums and apricots |
| | | | 0,2 | 0,6 | 1 | 0,4 | |

To describe the process of electropulse treatment in the area of interest to us, according to the results of preliminary experiments, the equation

$$Y = b_0 + \sum_{i=1}^{3} b_i x_i + \sum_{i=1}^{3} b_{ij} x_i x_j + \sum_{i=1}^{3} b_{ij} x_i^2 \quad (1)$$

When calculating the regression coefficients included in the equation $b_j$ and $b_{jk}$, the plan of the factorial experiment of type $2^k$ was used. After processing the results of the experiment, regressive and dispersive analysis, a mathematical model of the process of electropulse processing of fruits and grapes was obtained. The repetition of the experiments was taken three times. When processing the results of experiments and carrying out statistical analysis of the process model, the techniques described in / 5,6 / are used. The research results allowed to obtain mathematical models of processes of electropulse processing (Table 2.) Regression and variance analysis of the mathematical model showed the significance of the regression coefficients and the adequacy of the constructed mathematical models. Analysis of mathematical models suggests that all three factors significantly affect the degree of tissue damage of grapes and fruits.

Mathematical models of processes of electric pulse processing of fruits and grapes

| Product Type | Mathematical Model | | The Equation |
|---|---|---|---|
| | With Coded Variables | With Natural Variables | |
| Plum "Isfandyk" | $Y = 4 + 0{,}62x_1 + 0{,}82x_2 + 1{,}4x_3 + + 0{,}12x_1^2 - 0{,}26x_2^2 - 0{,}3x_3^2 + + 0{,}05x_1x_2 + 0{,}51x_2x_3$ | $S = 8{,}94 - 0{,}94U + 0{,}11n + 6{,}9C + + 0{,}053U^2 + 0{,}1n^2 - 26C^2 + + 0{,}19Un + 0{,}33Un + 2{,}55nC$ | (2) |
| Apples | $Y = 2{,}4 + 1{,}13x_1 + 0{,}66x_2 + 0{,}8x_3 + + 0{,}04x_1^2 - 0{,}15x_2^2 - 0{,}18x_3^2 + + 0{,}63x_1x_2 + 0{,}6x_1x_3 + 0{,}580{,}6x_2x_3$ | $S = 2{,}16 - 0{,}24U - 0{,}18n - 3{,}83C - - 0{,}63U^2 + 0{,}29n^2 + 0{,}091C^2 + + 0{,}05Un + 0{,}33Un + 0{,}95UC + + 0{,}3nC$ | (3) |
| Apricot | $Y = 8{,}56 + 4{,}41x_1 + 1{,}49x_2 + 1{,}69x_3 - - 1{,}91x_1^2 - 0{,}535x_3^2 + 0{,}59x_1x_2 + + 0{,}99x_1x_3$ | $S = -20{,}08 + 2{,}8U - 0{,}53n + 3{,}1C - - 0{,}33U^2 - 0{,}01n^2 + 0{,}16Un + + 2{,}95UC$ | (4) |
| White Sultana grape | $Y = 11{,}18 + 2{,}876x_1 + 2{,}53x_2 + + 3{,}826x_3 - 2{,}31x_1^2 + 0{,}083x_2^2 + + 0{,}67x_3^2 + 0{,}707x_1x_2$ | $S = -55{,}18 + 2{,}876U + 0{,}42n + + 11{,}42C - 2{,}31U^2 + 0{,}013n^2 + + 5{,}98C^2 + 2{,}11UC$ | (5) |
| Black Sultana grape | $Y = 11{,}605 + 2{,}447x_1 + 2{,}486x_2 + + 3{,}538x_3 + 1{,}98x_1^2 + 0{,}062x_2^2 + + 0{,}73x_3^2$ | $S = -43{,}18 + 2{,}44U + 0{,}513n + + 10{,}68C + 1{,}98U^2 + 0{,}017n^2 + + 6{,}51C^2$ | (6) |
| Nimrang Grapes | $Y = 7{,}13 + 1{,}87x_1 + 2{,}01x_2 + + 1{,}024x_3 + 1{,}13x_1^2 - 0{,}051x_2^2 + + 0{,}48x_3^2 + 0{,}83x_2x_3$ | $S = -21{,}3 + 19{,}8U + 0{,}35n - - 0{,}49C + 0{,}97U^2 + 0{,}015n^2 - - 0{,}32C^2 - 0{,}62nC$ | (7) |
| Tayfi grapes | $Y = 6{,}89 + 2{,}08x_1 + 1{,}76x_2 + + 1{,}623x_3 - 1{,}08x_1^2 + 0{,}048x_2^2 + + 0{,}36x_3^2 - 0{,}56x_1x_3$ | $S = -18{,}3 + 1{,}62U + 0{,}44n - - 0{,}82C + 0{,}98U^2 - 0{,}033n^2 - - 0{,}41C^2 + 0{,}29UC$ | (8) |
| Muscat grapes | $Y = 8{,}41 + 2{,}13x_1 + 2{,}07x_2 + + 1{,}782x_3 + 1{,}23x_1^2 - 0{,}06x_2^2 + + 0{,}51x_3^2 + 0{,}85x_1x_3$ | $S = -21{,}7 + 2{,}01U + 0{,}68n + + 0{,}95C - 0{,}87U^2 + 0{,}042n^2 - - 0{,}25C^2 - 2{,}44UC$ | (9) |

The most significant of the factors of the three factors is the capacity of the discharge capacitor (C). The second in importance in the equations given in Table. 2 are factors factors$X_1$, $X_2$(equations 6,8,9). We also carried out studies on the effect of the developed technology of preliminary pulsed processing on the intensity of the subsequent drying. Studies were conducted on a special laboratory model of a convective drying unit equipped with special measuring devices. When determining the effect of electrical treatment and the parameters of the drying agent on the kinetics of drying, the degree of damage S, temperature T and the speed of movement of the drying agent V were taken as variable factors. The object of the study was the Sultana Black grape. The experiments were carried out in six replicates by measuring the temperature and speed of the drying agent, taking into account changes in the mass of the dried products and time T. According to the results of experimental studies and their mathematical processing, drying curves were obtained (Figure 10). An analysis of

the drying curve suggests that the average duration of drying of fruits and berries subjected to electrical treatment is 1.5–1.8 times less than the chum of untreated products. The degree of influence of pre-treatment on the duration of the process can be characterized by a relative coefficient of reduction of the duration of drying ( $K_s$ )defined as the ratio of the duration of drying of the non-processed $\tau'$ product to the processed: $\tau''$ : $K_s = \frac{\tau'}{\tau''}$.

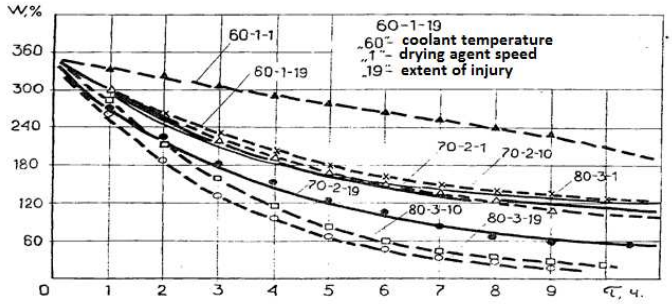


**Figure 10: Curve Drying Grapes Sultana Black**

## FINDINGS

- The main parameters of electrical processing with pulsed discharges are the discharge voltage (Up) (electric field intensity), the capacity of the discharge capacitor C and the number of pulses n
- The maximum degree of damage to the tissue of fruits and grapes is achieved with processing parameters U = 3-7 kV; C = 0.3-0.4 μF, n = 8-18 pulses
- Graphic dependencies and mathematical models of the process of electrical processing of fruits and grapes characterize the regularities of the process and can be used in engineering calculations and in the design of an electrical pulse installation
- The energy of a single pulse depends on the resistance of the discharge channel, its upper limit is limited by the allowable density of the discharge current at the places of energy input (for different grapes $W = 5*10^{-3}$kJ for fruits $W=9*10^{-3}kJ$ ), lower - insufficiency of the damaging effect;
- Liquid blanching of fruits and grapes allows only slightly affecting the cells of tissue S = 2.5–5 (mainly the skins of the surface tissue) with significantly higher specific energy costs $W$=250-300 kJ/kg
- Preliminary electro pulse treatment reduces the duration of the drying process and reduces energy costs for its implementation, and the effect of the degree of damage on the intensification of drying at S < 50% is insignificant, a further increase in S is characterized by a sharp increase in its efficiency, and at S > 85-90 % there is a constancy of the duration of the process.

## THANKS

- Fundamental project КХ-4Ф-22 on the theme "Scientific and methodological principles of saving thermal and electric energy in agricultural production" (2012-2014) Tashkent state agrarian university “TSAU”
- Applicable project ҚХА-9-100, Development of energy-resource shunting, environmentally safe

electrotechnologies and technical means of storage and processing of agricultural products based on the integrated use of traditional and renewable energy sources. "(2012-2014)" “TSAU”

- Innovative project ҚХИ-3-001-2013 on "Development and application of a unified modular biogas plant" (2013-2014) “TSAU”
- Application project ҚХА-4-004-2015 - "Development of a local energy supply system for consumers of farms specializing in fruit growing and viticulture based on the integrated use of renewable energy sources," 2015-2017 y. “TSAU”
- Is the executor of the Interagency Innovative Project jointly carried out by the Scientific Research Institute of Power Automation of the Academy of Sciences of the Republic of Uzbekistan and “TSAU” (И-2015-3-4) "Development and development of production of energy-efficient equipment and renewable energy sources with the creation of a demonstration-testing ground", 2015-2016
- Is the executor of the innovative project (И-204-15-2-21)performed in the Research Institute: Power engineering and automation of the Academy of Sciences of the Republic of Uzbekistan - "Development, creation and implementation of mini HPPs**(** *hydroelectric power plant*) up to 100 kW with increased power quality indicators and preparation of RES literature", 2015-2016.

***REFERENCES***


1. *N. K. Thakur, N. S. Thakur Drying of Fruits and Vegetables. Postharvest Technology of Fruits & Vegetables, Indus Publishing Co., New Delhi, India (2000) pp. 821–895*
2. *Beker CGJ (2005) Energy efficiency in drying. Stewart Post-harvest Rev 4:8–12*
3. *Pento V. B. Technology and technology of drying. // Food industry.2005. № 9 * - P. 14-16.*
4. *Tzempelikos DA, Vouros AP, Bardakas AV. Case studies on the effect on the effect of the air drying conditions on the convective drying of quinces. Case Studies in Thermal Engineering. 2014;3:79-85*
5. *Mirzaev, M. M., etc. Technology of cultivation and drying of grapes.-Toshkent.: Uzbekistan, 1982.-41 p.*
6. *Ajayi, j., & olasunkanmi, s. application of wkb method in evaluation of energy eigen value of a symmetric parabolic alas quantum well structure.*
7. *Moses JA, Norton T, Alagusundaram K, et al. Novel drying techniques for the food industry. Food Engineering Reviews. 2014;6:43-55.*
8. *Erle U (2005) Drying using microwave processing. In: The microwave processing of foods. Schubert H, Regier M (ed), Wood-head Publ, Cambridge, England, p 142–152*
9. *Boyko. A. AI Electroplosmolysis of plant objects // Mechanization and electrification of socialist agriculture 1977 №2 p.42*
10. *Romaswanny H., Voort F. R. Van de. Microwave applications in food processing // Can. Eust., Food Sci. Am Technol. Y. 1990. V. 23. № 1. P. 17−21.*
11. *Schreier, P., Reid, D., and Fryer, P. (1993). Enhanced diffusion during the electrical heating of foods. Int. J. Food Sci. Technol., 28, 249-260.*
12. *Method of preparing fruits and grapes for drying. A. Rajabov, M. Mirzaev, A. Mukhammadiev, E. V. Stavikin, A. Kh. Vahidov*

*(USSR) No. 3493088 / 28-13; Declared September 22, 822; published 15.05.84. bul. No. 18.*

13. *A. S. SSSR No. 13981123. Method of preparing melons for drying. Radzhabov A., Muratov H., Rasulov A. January 22, 1988*
14. *Bai, B. J., & KUMAR, C. R. (2014). Dynamic model and control of DFIG wind energy systems based on power transfer matrix using SVPWM. International Journal of Electrical and Electronics Engineering (IJEEE), 3(1), 27-36.*
15. *A. S. SSSR № 1614785. Devices for preparing plant materials for drying. Radzhabov A., Muratov H., Faizullaev S., Muzaffarov S. August 12, 1990*
16. *A. S. No. 1758925. Method for drying melon pulp. Radzhabov A., Muratov H., Ahmedov O., May 1, 1992*
17. *Radzhabov A., Khasanov U. Electroprocessing of products before drying // Food Industry, 1991. N4.-p.65-67.*
18. *Radzhabov A. Fundamentals of energy-saving technology of drying food products. "Herald of agricultural science",1991. N5.-p. 68-72*
19. *Radzhabov A., Muratov H., Ismoilov M., Scientific basis of energy perfection production of dried fruits and sultana grape. Monograph. Tashkent.: Mehnat, 1993.-p.110*
20. *kumar, u., & singh, d. electronic waste: concerns of lighting lamps in jharkhand.*
21. *Radjabov A. Methodological foundations of energy-saving electrical technology of drying fruits and grapes. Author. doc diss. - Chelyabinsk, 1991. - 36 p.*
22. *Radjabov A., MuratovKh., Ismoilov M. Scientific bases of energy improvement, the production of dried fruits and raisins. Tashkent.: Mehnat, 1993.-p.110*
23. *Vinarsky M. S., Lurie M. S. Planning of an experiment in technological experiments.-Kiev.: Technique, 1975.-168 p.*
24. *rumshinsky l. z. mathematical processing of experimental results. -m.: science, 1971.*
25. *hsiao, m. the provision of sustainability information for electronic product consumers through mobile phone technology.*
26. *Abramov N. V. Studying the effect of electrophysical factors on biological objects // Electronic processing of materials. 1980. - № 5. - p. 57-60*
27. *Borodin N. A. The choice of electrical circuit modeling of the grain mass. // Mechanization and electrification of socialist agriculture, 1971. No. I. - P. 40-41..*
28. *Baer V. Biophysics. - M.: Foreign Literary., 1962. - p. 430.*